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ABSTRACT

In July 1983, the Board of Advanced Education, Queensland, Australia, considered the problem of the acute shortage of secondary science and mathematics teachers and the role of teacher education in remedying the situation. The Board of Teacher Education was approached and asked to investigate matters pertaining to the supply and education of mathematics and science teachers within the state. This document represents the executive summary of the report of the Working Committee appointed by the Board of Teacher Education to carry out the investigation. Summarized are the report's information and recommendations pertaining to: (1) teacher crisis in mathematics and science; (2) participation, achievement and attitudes of secondary students in science and mathematics; (3) mathematics and science in the curriculum; (4) the current education of science and mathematics teachers; and (5) future directions in the education of science and mathematics teachers. (TW)

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TEACHERS FOR MATHEMATICS AND SCIENCE

EXECUTIVE SUMMARY

Working Party on the Preparation of Teachers in Mathematics and Science

TEACHERS FOR MATHEMATICS AND SCIENCE

EXECUTIVE SUMMARY

Introduction

The Working Party was established by the Queensland Board of Teacher Education to consider the issues involved in teacher supply and quality in the areas of mathematics and science. The terms of reference for the Working Party were:

- a review of the projected need for science and mathematics teachers in Queensland;
- an examination of the various routes and courses currently available for the education and training of science and mathematics teachers;
- an examination of the quality and quantity of entrants to such courses and possible means of obtaining sufficient numbers of entrants of the requisite quality;
- an examination of the mathematics/science curriculum in relation to the total secondary curriculum, with specific consideration being given to the attitudes developed in mathematics/science through the curriculum process and current methodologies;
- consideration of pathways in tertiary education for mathematics/science teaching including in-service education for teachers trained in these areas and conversion courses for teachers whose preparation was in other areas;
- a review of the literature on the participation of students in mathematics/science and mathematics/science teacher education courses;
- such other matters as may be relevant to the provision of an adequate supply of qualified teachers in these areas.

The Working Party recognised that its terms of reference were far reaching in scope and would involve not only an investigation of teacher supply and quality in the areas of mathematics and science, but also consideration of various aspects of the school mathematics and science curriculum. Information before the Working Party pointed to a critical shortage of mathematics and science teachers. Thus, while the Working Party was cognisant of the need to consider some of the broader issues in depth, it nevertheless was also conscious of the need for a set of interim recommendations to assist in providing more immediate solutions to some of the difficulties. Accordingly, an interim report was produced by the Working Party in December 1983. The interim report contained a total of 18 recommendations.

Most of these were concerned with increasing teacher supply in mathematics and science. Other recommendations related to routes of entry and courses available for the education and training of mathematics and science teachers and additional provisions for mathematics and science teachers in their early years of teaching. The Working Party was gratified to note that some of the recommendations made in the interim report were acted upon during 1984.

In approaching the task of considering in detail all of its terms of references, the Working Party was able to conceptualize its task into five major areas, which form the basis of the chapters of the main report. These are: The Teacher Crisis in Mathematics and Science; Participation, Achievement and Attitudes of Secondary Students in Science and Mathematics; Mathematics and Science in the Curriculum; The Education of Science and Mathematics Teachers; and Future Directions in the Education of Science and Mathematics Teachers.

The underlying premise of the Report is essentially that the demand for Mathematics and Science by secondary students and hence the supply of potential Mathematics and Science teachers is largely contingent on the attractiveness of the Mathematics and Science curricula in schools. The small amount of time allocated to Science teaching in the primary school, the propensity to crowd too much into secondary Mathematics and Science curricula and the tendency to emphasize learning procedural routines rather than achieving a conceptual understanding all contribute to Mathematics and Science curricula which fail to reach many students. Indeed present Mathematics and Science curricula may alienate many potentially capable students who otherwise might be motivated to pursue a teaching career in Mathematics and Science. The Working Party's concern for the quality of the Mathematics and Science learning process in schools and the connection between this process and the supply and preparation of teachers of Mathematics and Science have led to the inclusion in the Report of a series of recommendations on the reform of Mathematics and Science curricula in schools.

While the Working Party's terms of reference focus the review on Mathematics and Science teaching at the secondary level, it is important that attention also be drawn to the need for primary school children to be taught Mathematics and Science in an exciting way. In particular, the one hour per week allocated to science in the primary school curriculum seems far too little and must militate against the early development of positive attitudes towards science learning. At the same time a major problem is also felt to exist at the junior secondary level where students are streamed into Ordinary and Advanced Mathematics classes, usually at the end of Year 8, thereby effectively closing doors to student participation in Mathematics later in their school careers. The Working Party proposes that this streaming practice be discontinued and that a common Mathematics subject be available for all students in Years 9 and 10. Naturally, this proposal carries with it the challenge of catering for individual differences and the wide range of mathematical abilities amongst students at the junior secondary level.

The Working Party has also advocated a need for more integration of the Science curriculum, especially at the Year 11 and 12 levels, without at the same time attenuating the integrity of the constituent disciplines. For example, primary teachers are generally well prepared to teach across curriculum areas but, at the secondary level, there seems to be too much stress on teaching within discrete subject areas. This concentration on the narrow task is also reflected in insufficient attention being given by some secondary Mathematics and Science teachers to fostering the pycho-social development of students and inadequate emphasis on the human element of technological studies. A more positive attitude might be fostered by concentrating on the teaching of a smaller number of fundamental concepts in order to facilitate a better conceptual grasp of underlying processes and principles as distinct from the memorising of structural routines. The present Mathematics curriculum transition between Year 10 and Year 11 might need revision in order to harmonise curriculum content more closely with the range of cognitive development evident at that stage. There should be more emphasis on curriculum continuity and less on the sharp discontinuity that existed at present.

In agreeing with the main thrust of the Report, the Board notes that many of the observations made in relation to the preparation of Mathematics and Science teachers might apply with equal force to the preparation and employment of teachers in other fields. For example, in Recommendation 4.4, the Working Party suggests that the appropriateness of the present three-year Diploma of Teaching courses as the minimum qualification for entering secondary Mathematics and Science teaching should be reviewed. This recommendation raises the more general question of the appropriate minimum period of pre-service teacher education for all subject areas at various levels together with the question of the appropriate mix in pre-service courses between "academic content" studies and "professional" studies.

As it receives the Working Party's Report, the Board has just embarked upon a major review of teacher education and registration in Queensland under the title **Project 21 : Teachers for the Twenty-first Century**. At the same time, discussions are continuing of a paper prepared by the Queensland Department of Education entitled **Education 2000 : Issues and Options for the**

Future of Education in Queensland. Many of the recommendations put forward by the Working Party will provide a major input to broader issues of school curricula and teacher preparation which are being addressed in the context of these reviews. Again, the outcome of these broader reviews will inevitably influence present perceptions concerning Mathematics and Science curricula and the preparation of teachers for mathematics and science.

In giving its general endorsement to the Working Party's Report, the Board notes that there are some specific recommendations concerning which it must at this stage express some reservations. For example, some Board members have serious reservations about the possibility of providing an adequate preparation, albeit at the postgraduate level, for mathematics and science teaching through external study, as suggested in recommendation 5.13. It may be argued that the secondment of teachers to work in tertiary institutions, while highly desirable in principle, should not be encouraged purely as a means of providing additional teaching resources to accommodate extra students as suggested in recommendation 5.9. Again, recommendations 5.4 part (iii) and 5.20, which suggest that employing authorities consider providing special conditions for mathematics and science teachers if not extended to all subject areas, might be seen as discriminatory against other teachers. The Board will be addressing these issues in particular in the coming months as well as discussing the Working Party's recommendations with all involved to explore ways of enhancing the supply and quality of teachers for mathematics and science.

While many of the recommendations contained in the report are not directed to particular audiences, the Board has taken up the suggestion made in recommendation 5.39 and has appointed a steering committee to follow up the other recommendations. As its first task the steering committee has been asked to identify the appropriate audiences for each recommendation and to suggest to the Board a strategy for directing the recommendations to these audiences.

The Teacher Crisis in Mathematics and Science

The Working Party reviewed evidence which showed that the shortage of suitably qualified mathematics and science teachers was a worldwide problem, not confined to Queensland or the other Australian states.

In order to gain a more accurate indication of the current Queensland staffing situation in mathematics and science the Working Party drew on evidence from two studies: a survey of principals' perception of the adequacy of current staffing in science and mathematics carried out by the Board of Teacher Education, and a study of the qualification of science and mathematics teachers undertaken by the Working Party itself. These studies confirmed the need for more mathematics and science teachers with appropriate qualifications.

The Working Party examined demand and supply for mathematics and science teachers as reflected in actual number of entrants to pre-service teacher education courses compared to numbers proposed by the Board of Advanced Education. The demand and supply situation varied among programs, although it was evident that there was a large shortfall in the number of entrants to the Brisbane College of Advanced Education Diploma of Teaching compared with proposed enrolments. Further, there was evidence that some suitably qualified candidates were not gaining entry to the Graduate Diploma in Teaching program at Brisbane College of Advanced Education because of lack of resources to cater for additional students.

Causes of the shortage of mathematics and science teachers were examined. These included – societal expectations and norms with regard to teachers which might dissuade young people from turning towards teaching as a career; the developing information and technological culture; stress on mathematics and science teachers which may cause them to seek alternative career opportunities; the need for more support for teachers of mathematics and science; and the small supply of girls entering mathematics and science teaching because of sex differences in relation to performance, participation and attitudes.

The Working Party realised that the recursive nature of the problem will mean that long-term solutions might exacerbate the current shortage while more superficial short-term measures could be detrimental in the long term. Multifarious solutions to the shortage are adumbrated, including: changes to recruiting procedures; changes to the structure and entry requirements of teacher education programs; improvements to the secondary science and mathematics curricula; improved public support for mathematics and science teachers and programs.

Recommendations concerning these solutions are given in subsequent chapters. In the first chapter, the need for more up to date information on the demand for mathematics and science teachers is embodied in the Working Party's recommendation

R1.1 that annual reviews of teacher supply and demand in Queensland be conducted during the first half of each year.

Participation, Achievement and Attitudes of Secondary Students in Science and Mathematics

An examination of participation patterns of secondary students in mathematics and science courses in Queensland revealed that a declining proportion of the Year 12 population was studying Mathematics I, Mathematics II, Physics and Chemistry, while there had been an increase in popularity of Biological Science and Social Mathematics or Mathematics in Society. The participation rate of girls in traditional mathematics and science subjects had remained below that of boys. While the Working Party was able to identify some possible causes of changes in subject choice, it considered that a more thorough study of subject choice should be made.

The Working Party also examined the literature on achievement and attitudes of secondary science and mathematics students, including changes over time and factors affecting attitude and achievement. It was found that negative attitudes to mathematics and science could develop early and that it was therefore highly desirable for students to experience quality teaching of mathematics and science in the lower secondary school. Research on sex differences in achievement and attitudes and the reasons for such differences were examined. A number of recommendations concerning studies into attitude and achievement of students towards science and mathematics were made by the Working Party

R2.1 that a longitudinal research study be undertaken to determine reasons for subject choice, with particular reference to differences in subject selection between the sexes;

R2.2 that longitudinal studies of achievement and attitudes in science and mathematics be undertaken to:

- identify achievement trends during primary and secondary schooling;
- identify attitude trends during primary and secondary schooling;
- determine factors which influence performance in science and mathematics at various stages of schooling; and
- determine factors which influence attitudes in science and mathematics at various stages of schooling;

R2.3 that research studies be undertaken to investigate the effect of sex-related variables on attitudes to science and mathematics at various stages of schooling; and

R2.4 that training packages be developed to enable students, particularly females, to become aware of the factors which contribute to negative attitudes towards science and mathematics and to counsel students towards more positive, confident vocational orientations.

Mathematics and Science in the Curriculum

The Working Party examined the historical development of mathematics and science curricula in Queensland secondary schools over the last twenty years. It was seen as essential that mathematics and science curricula continue to be reviewed.

Reviews of the curricula should endeavour to provide for a balanced and sequenced set of learning experiences which extend across all of the years of schooling. These curricula would be implemented so that mathematical and scientific concepts were introduced at points appropriate to children's level of development. The Working Party therefore strongly endorsed efforts aimed at curriculum continuity through the development of P–10 curricula. It also considered that review of curricula in Years 11 and 12 should be undertaken in conjunction with the P–10 review.

From its historical analysis of the curriculum in Queensland, the Working Party noted that not all students studied science up until the end of Year 10 and that the amount of time devoted to mathematics had decreased. It was therefore recommended that schools should give consideration to making science a compulsory core subject up to Year 10 and the amount of time devoted to mathematics be increased.

A development with which the Working Party was somewhat concerned was the practice of streaming students in the junior secondary school into Ordinary and Advanced Mathematics classes, usually at the end of Year 8. This was seen as closing the doors to student participation in mathematics later in their school careers.

Other issues in the development of mathematics and science curricula which the Working Party identified as being important in meeting the needs of students were: the necessity of examining curricula and resource material to ensure that they take into account the background knowledge and learning styles of girls; the need for mathematics and science curriculum changes to be implemented in such a way that they are able to respond more rapidly to educational and societal changes; and the desirability of examining certification procedures currently used at the end of Year 10.

Consideration of the methodology employed by mathematics and science teachers led the Working Party to the conclusions that teachers may be overemphasizing a formal transmissive approach rather than a more interpretative one. It was considered that science and mathematics curricula needed to be presented in a more compelling, exciting and relevant context. The Working Party was of the opinion that a more student-centred, realistic focus would improve students' attitudes and achievement. Mathematics and science teachers should also try to ensure that their teaching is relevant to boys as well as girls. In order to assist in bringing about such changes, the Working Party has recommended *inter alia* the further development of in-service courses for teachers that curriculum resource materials including textbooks be reviewed, that resources for mathematics and science teaching be improved and that schools be encouraged to provide support mechanisms for inexperienced teachers.

R3.1 that the procedures for developing and implementing syllabuses be examined with a view to creating mechanisms which will respond more rapidly to changes in education and society, particularly for those subjects which are affected by extensive technological change;

R3.2 that the examination of upper primary and lower secondary syllabuses in Science and Mathematics continue with a view to producing a P–10 curriculum which takes cognisance of integrating themes and key concepts in science and mathematics;

R3.3 that the syllabuses in Science and Mathematics be examined to determine if concepts are being introduced at points appropriate to children's level of development;

R3.4 that the current form of certification adopted at the end of Year 10 be evaluated and consideration given to accrediting schools/courses at that level;

R3.5 that more extensive in-service development programs for science teachers in secondary schools be provided to facilitate changes in science teaching methodologies foreshadowed in recent research and emerging curriculum programs;

R3.6 that the scope and content of science curricula at all levels of the secondary school be examined in order to determine whether there is a need to reduce the body of knowledge perceived to be required and to allow greater emphasis to be developed on concept acquisition, problem solving and process attainment;

R3.7 that those involved in ongoing curriculum development in science take account of differences in background knowledge and learning styles of females and males and that steps be taken within the organisation of science programs so that greater numbers of females may be attracted to study Senior Science;

R3.8 that, in keeping with trends both interstate and overseas, science be included as a core subject up to Year 10 in all secondary schools;

R3.9 that greater integration of key ideas be encouraged during teaching of science to Years 11 and 12 with an attendant reduction of the boundaries between science subjects in the senior school;

R3.10 that greater emphasis on the social effects of science and technology be incorporated into the Science curriculum at all levels;

R3.11 that resources for science teaching be improved through centrally co-ordinated developmental projects, so that key emphases in syllabuses are implemented;

R3.12 that the development of a curriculum aimed at achieving a balanced and coherent P–10 Science program continue;

R3.13 that available mathematics textbooks be continually reviewed and evaluated with a view to providing advice on those that may best suit teachers and schools, keeping in mind their appeal and relevance to girls. Improved mechanisms are needed to evaluate and provide information to schools on textbooks so that those which are inert, out of date and alienating students will be discarded;

R3.14 that in ongoing curriculum development in mathematics, greater efforts be made to:

(i) ensure more appropriate selection and sequencing of learning in topics such as algebra, geometry, ratio and fractions;

(ii) encourage the use of meaningful learning experiences with calculators and computers;

(iii) eliminate unnecessary use of logarithm tables and trigonometric tables; and

(iv) de-emphasise the range of content and emphasize acquisition of concepts, applications, processes and problem solving;

R3.15 that the amount of content in Senior Mathematics units be reduced and in collaboration with tertiary institutions the Mathematics curriculum in Years 11 and 12 be reviewed in conjunction with the P–10 curriculum review;

R3.16 that the practice of streaming Year 9 and Year 10 mathematics classes into Advanced and Ordinary Mathematics be discontinued and that one mathematics subject be available for all students in Years 9 and 10;

R3.17 that all groups including administrators, subject masters and other teachers associated with the education of teachers of mathematics affirm the need for mathematics learning to take place in an active, exciting and caring environment characterised by a variety of approaches and organisational strategies;

R3.18 that resources for mathematics teaching be improved through centrally co-ordinated developmental projects, so that key emphases in syllabuses are implemented;

R3.19 that in view of the strong evidence that time is a significant variable in mathematics learning, more time be allocated to the teaching of mathematics and that mathematics teachers be better prepared to manage time more effectively in classroom learning experiences;

R3.20 that those involved in ongoing curriculum development in mathematics take account of the distinctive background knowledge and learning styles of females and that steps be taken within the organisation of mathematics to attract greater numbers of females to Senior Mathematics and place greater emphasis on the development of spatial abilities in female students;

R3.21 that all teachers be encouraged to place greater emphasis on diagnostic teaching strategies wherein specific emphasis is given to assisting students to recognise their own learning problems and to facilitate improved learning by their own initiative; and

R3.22 that schools be encouraged to provide support mechanisms for inexperienced teachers of mathematics, particularly through organisational processes which would allow inexperienced teachers regularly to consult with and teach with highly competent colleagues.

The Education of Science and Mathematics Teachers

The literature concerning the desirable personal and professional qualities of mathematics and science teachers was examined by the Working Party. It was considered that school leavers and other persons who may be interested in science and mathematics teaching should be made aware of the personal and professional qualities that are desirable in mathematics and science teachers.

The Working Party examined the current programs available for the preparation of mathematics and science teachers and the entry requirements for each of the courses. It is recommended that a review of the minimum qualification for entering science and mathematics teaching be undertaken. It was noted that a Master's degree in Mathematics Education is available in the advanced education system in Queensland, while a Master's degree in Science Education is not offered. Given the major commitment of the advanced education system in Queensland to the preparation of science teachers, a recommendation was made concerning the offering of a Master's degree in Science Education.

R4.1 that employing authorities and tertiary institutions involved in teacher education be encouraged to co-operate in the development of pamphlets and brochures which promote science and mathematics teaching and describe personal and professional characteristics of science and mathematics teachers;

R4.2 that actions be taken through in-service education to acquaint science and mathematics teachers with the importance of various aspects of their personal and professional roles;

R4.3 that science and mathematics teachers be made more aware of the importance of their role in attracting persons with high academic ability, especially school leavers, to enter science and mathematics teaching;

R4.4 that the raison d'etre for Diploma of Teaching courses as the minimum qualification for entering science and mathematics teaching be reviewed;

R4.5 that further consideration be given to the need for a Masters degree course in Science Education at one of the colleges of advanced education.

Future Directions in the Education of Science and Mathematics Teachers

The Working Party considered that it was necessary to undertake a number of courses of action to attract quality entrants into mathematics and science teaching. These included the need for more publicity on the current shortage of mathematics and science teachers; the offering of scholarships, bursaries and special financial incentives; and the offering of part-time and external courses. It was considered that there should be more flexibility to allow for greater numbers of student places to be made available at short notice if there was a high demand by students for mathematics and science teacher education courses. Consideration should be given to amending the admissions requirements and course structures to allowable students without required entry subjects into courses which prepare mathematics and science teachers.

The Working Party made a number of recommendations to employing authorities to enhance the recruitment and employment of mathematics and science teachers. These included: advertisement of positions in specific schools; offering permanent part-time employment; provision of career paths which allow quality teachers to remain in classroom teaching positions; and reducing the range of content areas or year levels which mathematics and science teachers are required to teach.

Given the critical nature of the first year of teaching to a teacher's confidence and competence over his or her whole career, a number of recommendations aimed at assisting with the induction of beginning teachers are made. It is nonetheless evident that improvement in the teaching of mathematics and science is largely in the hands of experienced teachers. The Working Party therefore considered it especially important that teachers be provided with appropriate in-service support.

The Working Party was of the opinion that public support for mathematics and science teachers was at a critically low level and that steps needed to be undertaken to improve the situation. These included the fostering of communication and collaboration between parents, teachers, teacher educators and professional mathematicians and scientists in business and industry.

The Working Party realised that it had made a large number of recommendations aimed at several organizations. Because of the breadth and complexity of its recommendations, the Working Party thus considered that a group should be appointed to monitor their implementation

R5.1 that the Minister release further press statements drawing attention to the current shortage of mathematics and science teachers and stressing within a period of rapid technological change the importance of sound teaching in mathematics and science for all pupils and encouraging school leavers, new graduates in mathematics and science and other suitably qualified persons in the community to enter appropriate courses with a view to becoming teachers of mathematics and science; and

R5.2 that tertiary institutions, employing authorities and schools adopt a more active role in encouraging suitably qualified people to enter courses in science and mathematics teaching and in raising the image of science and mathematics teaching as a career;

R5.3 that, while the shortage of mathematics and science teachers continues –

(i) the number of scholarships and bursaries offered by employing authorities for pre-service teacher education courses in mathematics and science be substantially increased;

(ii) that such bursaries be offered during the first year of study as an added incentive for students to undertake mathematics and science teacher education courses;

(iii) that bursaries also be made available in the final year of a Bachelor's degree to students who intend to undertake a Graduate Diploma course in Teaching or a Diploma in Education course leading to a career as a mathematics or science teacher;

R5.4 that, while the shortage of mathematics and science teachers continues, persons with suitable qualifications in mathematics or science and appropriate experience be encouraged to undertake a graduate diploma in teaching or diploma in education by means of special financial incentives including:

(i) living allowances and other financial support to enable them to engage in full-time study;

(ii) modification of the conditions on TEAS which prevent students from supplementing their income; and

(iii) recognition of all or some of any prior industrial experience they may have in determining commencing salaries within the appropriate scale;

R5.5 that institutions publicize to undergraduate students in mathematics and science courses the requirements and procedures pertaining to entry to pre-service post-graduate teacher education courses;

R5.6 that universities and colleges closely monitor the offering of places in pre-service secondary teacher education courses through the Queensland Tertiary Admissions Centre with a view to ensuring that all suitable applicants wishing to become mathematics and science teachers are admitted;

R5.7 that additional resources be provided for tertiary institutions to allow the intake of science and mathematics teacher education students to be increased at short notice, particularly in the Graduate Diploma in Teaching and the Diploma in Education;

R5.8 that tertiary institutions consider the need for greater flexibility in staffing through the use of secondments, the employment of part-time staff and other means so that they can respond quickly to the availability of extra students in areas of teacher shortage;

R5.9 that all employing authorities be encouraged to continue to second suitably qualified teachers to tertiary institutions to provide additional teaching resources to accommodate extra student numbers;

R5.10 that, in view of the restructuring and reallocation of higher education resources which has taken place over the 1982–84 triennium and having regard to the current shortage of teachers in areas such as mathematics and science, the Commonwealth Tertiary Education Commission be requested formally to withdraw its policy on the filling of vacancies in teaching staff in faculties and schools of education by universities and colleges;

R5.11 that tertiary institutions consider amending their admission requirements and course structures to provide an alternative pre-service science and mathematics teacher education course for able students who lack the presently required entry subjects in those areas;

R5.12 that consideration be given to the possibility of offering suitable bridging courses in science and mathematics for underqualified school leavers seeking entry to teacher education courses in those fields;

R5.13 that early consideration be given to the offering of pre-service graduate diploma courses in science and mathematics teaching by part-time evening or external study;

R5.14 that employment requirements for mathematics and science teachers be reviewed with a view to reducing either the range of content areas or year levels of the school curriculum which teachers are required to teach;

R5.15 that provision be made for a limited number of students to undertake secondary teacher education courses specializing in only one teaching area, mathematics or science;

R5.16 that, wherever possible, teachers not be required to teach in areas of mathematics and science for which they have had not received an adequate professional preparation;

R5.17 that tertiary institutions include in their pre-service teacher education courses in science and mathematics studies that make students more aware of the importance of sex-related factors in the teaching/learning process and stress the importance of a personalised approach in teaching mathematics and science;

R5.18 that employing authorities be encouraged to advertise through local and State newspapers positions in science and mathematics teaching associated with particular schools;

R5.19 that the establishment of permanent part-time positions for science and mathematics teachers be encouraged;

R5.20 that further consideration be given to the possibility of providing status and salary rewards for high quality teachers in science and mathematics which do not require them to withdraw from classroom teaching;

R5.21 that close attention be given by principals and subject masters/mistresses to the provision of an effective and sympathetic induction to the teaching profession for beginning teachers, particularly in science and mathematics;

R5.22 that beginning teachers of mathematics and science not be given full and immediate responsibility for teaching classes where students experience substantial learning difficulties;

R5.23 that beginning teachers be given realistic and carefully considered teaching loads. Too little variety such as the teaching of science or mathematics to multiple classes at one year level only could be just as detrimental as too much variety;

R5.24 that subject masters/mistresses, advisory teachers and consultants consider further ways of assisting beginning teachers to overcome problems of class management, classroom and laboratory organization, assessment, and lack of student motivation in learning that are so characteristic of the early teaching years;

R5.25 that employing authorities be encouraged to assist beginning teachers by providing greater numbers of advisory and consultant teachers, both in schools and via telecommunication links;

R5.26 that subject associations in science and mathematics be encouraged to place greater emphasis on the needs of beginning teachers and to identify among their members teachers who could organize in-service and continuing education programs especially for beginning teachers;

R5.27 that in-service training be provided by appropriate bodies to enable teachers to keep up to date with multistrand and life-role approaches to science teaching as well as advances in their discipline areas;

R5.28 that extensive and ongoing in-service education support be provided to re-orientate teachers' understanding of how children learn science and mathematics, given the continuing growth of knowledge in the field of cognitive learning;

R5.29 that employing authorities take steps to expand both school-based and systemic in-service teacher education programs in the areas of science and mathematics as a matter of urgency;

R5.30 that science and mathematics teachers be encouraged to collaborate and engage in discussions with other staff in schools in the areas of curriculum development and implementation;

R5.31 that tertiary institutions be encouraged to mount non-award continuing education courses in junior secondary mathematics and science teaching and that the support of employing authorities and teachers' unions in giving such programs high recognition be sought;

R5.32 that, within existing resources, school authorities, principals, subject masters/mistresses and teachers explore ways of making the typical mathematics or science classroom a more attractive place in which to work;

R5.33 (a) that additional staffing and financial provisions be made by employing authorities for the assessment of available resource materials for the teaching of mathematics and science, for the production of additional resources and for the necessary in-service programs to enable teachers to use such resources effectively in their classrooms

(b) that, in particular, resources be supplied to encourage and support initiatives in mathematics teaching;

R5.34 that Government and private funding agencies collaborate more widely with science and mathematics educators in relation to needed research into science and mathematics teaching and learning;

R5.35 that additional funds be made available for research and development in science and mathematics education;

R5.36 that community organizations and the media be encouraged to be supportive of science and mathematics teachers so that the attractiveness of the profession will be enhanced;

R5.37 that parents, teachers, and school administrators establish new and higher standards of co-operation and teamwork in the interests of attaining the common goal of educating students to their highest potential in science and mathematics;

R5.38 that governments at all levels facilitate the attainment of goals in science and mathematics agreed upon co-operatively by parents, mathematics and science teachers, teacher educators, professional mathematicans and scientists and other interested and involved parties;

R5.39 that the Board of Teacher Education consider appointing an independent group to monitor the implementation of the recommendations in this report.

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